Analytical Applications of the NAMEA

Applicazioni analitiche della NAMEA (Matrice di Conti Economici Integrata con Conti Ambientali)

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Riassunto: L'analisi Input-Output può essere proficuamente applicata ai dati della NAMEA per analizzare le pressioni ambientali delle attività produttive direttamente ed indirettamente connesse al soddisfacimento della domanda finale e rispondere così a domande sulle cause ultime del degrado ambientale di notevole importanza per la politica ambientale. I dati su emissioni e prelievi contenuti nella NAMEA sono stati messi in relazione con le tavole Input-Output diffuse dall'Istat. Per mezzo di un semplice modello Leontieviano sono state quindi calcolate le quantità dirette ed indirette di emissioni, input materiali, valore aggiunto e input di lavoro connesse ad ogni unità di domanda finale, per attività produttrice "verticalmente integrata", ponendo infine in relazione tra loro gli aggregati ambientali ed economici in tal modo calcolati.

Keywords: NAMEA, Emissions, Inputs, Input-Output Analysis, Emission Intensity, Resource Intensity, Vertically Integrated Activities, Direct and Indirect Flows, Activation by Final Demand.

1. Aims and Methodology

The present work has the aim of illustrating the usefulness of the NAMEA (National Accounting Matrix integrated with Environmental Accounts) for policy-relevant analysis, mainly based on the Input-Output (I/O) analytical model, by briefly explaining the kind of information that it can provide, and by presenting examples of the results obtained so far in the framework of an ongoing project.
Environmental policy questions often concern the *individual industries' absolute and relative direct contributions to environmental pressures and driving forces*, as well as their *efficiency* from an environmental point of view. The answers to these questions allow to identify the target industries of environmental policies. In the NAMEA framework the juxtaposition of coherent economic and environmental data allows to analyse the industries' eco-efficiency based on the observed ratios between direct physical inputs (and outputs) from (to) Nature (e.g. tons of minerals extracted of CO_2 emitted and of hazardous waste produced) and socio-economic variables on which data by production branch are available, such as, in the case of the Italian NAMEA, the value of production, value added and full-time job equivalents.
The most interesting policy-relevant use of the NAMEA data, however, is for tackling problems that need an analysis of system-wide interconnections. Suppose for instance that a policy-maker wants to steer final demand (consumption, investments, exports) so

as to reduce a certain pressure on the environment, e.g. the emissions of nutrients to water. For such a “structural” kind of policy it is important to know not just how much of the nutrients is *directly* emitted by the production of the demanded products – e.g. some kind of service – but also how much is caused *indirectly*, through the need for upstream production processes – e.g. that of the paper used in the production of that service. By applying I/O analysis to NAMEA data, a process of virtual reconstruction of the production chains can be realised, so as to provide the information required for that kind of policy. This is done by means of a computational re-classification of the activities, which are assigned to final output by product group according to their contribution (both direct and indirect) to its realisation. This operation is known as 'vertical integration' of the industries. A 'vertically integrated industry' gathers all the activities – no matter how inhomogeneous – that directly or indirectly contribute to the production of a certain final good or service, by providing the inputs needed at all stages of production in order to generate that product. Among the results of this operation are the total (direct and indirect) requests on the environment of the final demand for the products of each vertically integrated industry. This information provides the answer to the question: *the use and demand for which goods and services **causes** exchange flows with nature, and in what quantity?* These flows might be of valuable material resources such as ores or biomass, or of undesired discarded matter such as air emissions, or waste streams. The same kind of computational re-aggregation applied to the socio-economic variables such as value added or job equivalents, gives their total activation by kind of demanded product and demand source, and allows to compare the corresponding activations of environmental pressures to that of economically and socially relevant phenomena..
In the Italian case both the I/O tables and the NAMEA report data by homogeneous activities classified into NACE-based industries, so their combination is not problematic as it only requires their aggregation to a common feasible detail level. In some cases however it has been preferred to disaggregate NAMEA data by using the relative contribution of the branches to production, rather than to aggregate the I/O table, in order not to loose important information on the intermediate flows.

2. Some results

The application of I/O analysis to the Italian NAMEA data concerns intakes from nature (of Biomasses, Minerals and Fossil Fuels), emissions (of CO2, CO, N2O, NH3, NOx, SO2, CH4, NMVOC, Pb, PM10), value added and full-time-equivalent jobs, and consisted in the calculation, at a breakdown level of 50 branches, of the total flows of these variables activated by the final demand for the products of the Italian economy, in the years 1995 and 2000. On the basis of these results we calculated the ratios expressing the *eco-efficiency* of industries.
Two examples of the results obtained are shown in Figures 1 and 2. For simplicity, the 'vertically integrated industries' considered in the exercise are grouped into 14 product groups. These correspond to the different industries by which the observed emissions are directly caused and are identified by the respective NACE codes[(1)]. It is important to

[(1)] 1-5 = *agriculture, hunting, forestry and fishing*; 10-14 = *mining and quarrying*; 15-37 = *manufacturing* (food product, beverage and tobacco, textile products, leather products, wood products, pulp, paper,

stress that these results only concern production activities: environmental pressures caused by the use of goods by households are not included. Figure 1 concerns CO2 emissions in the year 2000, analysed by product group and according to the different categories of final demand to which the same emissions are traced back. The main activation of these emissions comes from Final Consumption, and precisely from the purchases of industrial goods and of energy by households; also the purchase of services, of which Public Administrations are a major user, gives, however, a relevant contribution, though mainly an indirect one. Emissions caused in the production of Exported products are strongly concentrated in manufacturing industry (15-37), while Investments cause emissions mainly in construction activities (45).

Figure 1: *CO2 emissions (direct and indirect) traced back to final uses, by vertically integrated industry, Italy, 2000 (tonnes).*

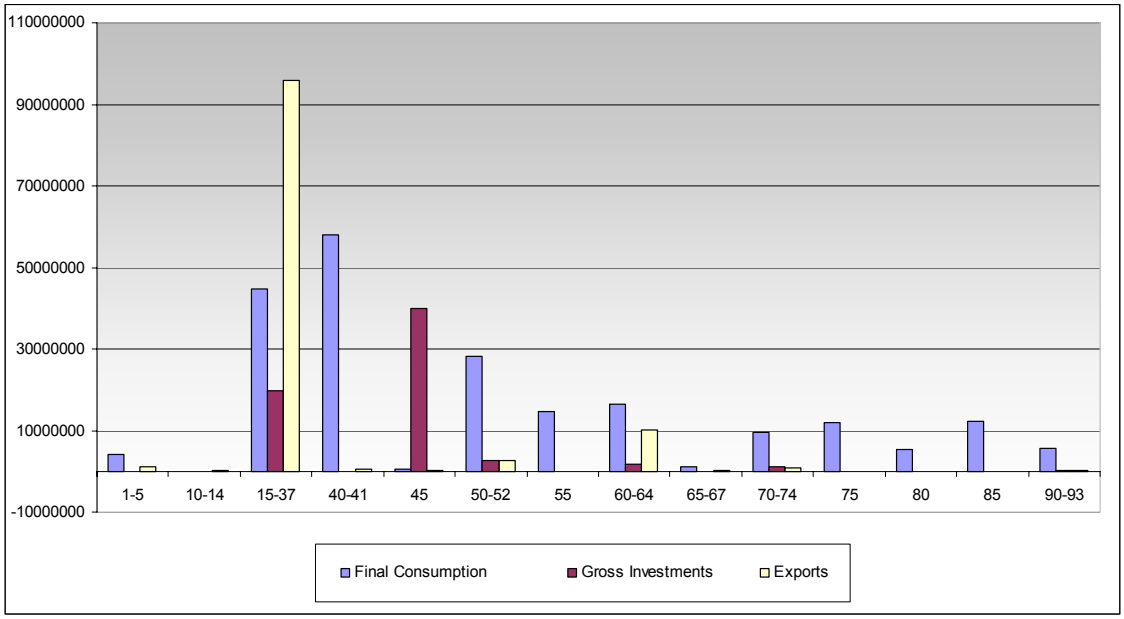

Figure 2 shows, for the same year, the ratios between activated lead emissions and, respectively, the activated value added and labour input (full-time equivalent jobs). As it can be seen, it is final energy consumption that activates the highest quantity of lead emissions per labour input unit, while it comes only third - after manufacturing and construction - in a ranking by intensity of lead emissions activated per unit of activated value added. These ratios express the trade-off embodied in the existing technology between environmental targets on the one hand and economically and socially relevant variables on the other hand, in a "meso" perspective (i.e. at sectorial level). Service activities are on average more efficient from an environmental point of view, though

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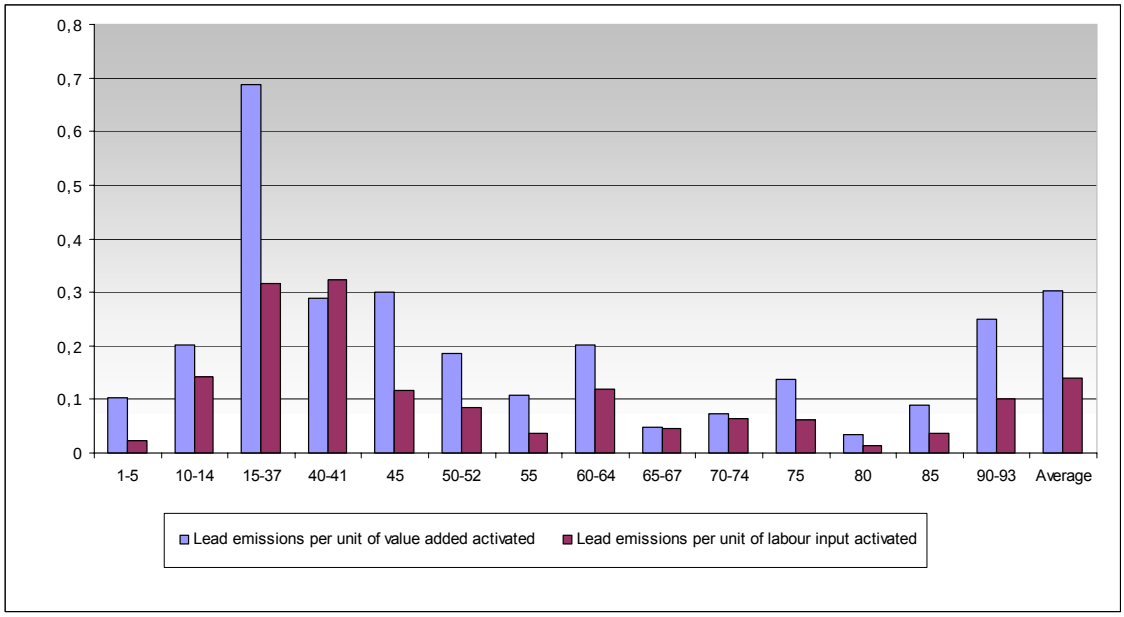
publishing and printing products, coke, refined petroleum products and nuclear fuel, chemical products and man-made fibres, rubber and plastic products, non-metallic mineral products, basic metals and fabricated metal products, machinery and equipment, electrical and optical equipment, transport equipment); 40-41 = *electricity, gas and water supply*; 45 = *construction*; 50-52 = *wholesale and retail trade, repair of motor vehicles, motorcycles and personal and household goods*; 55 = *hotels and restaurants*; 60-64 = *transport, storage and communication*; 65-67 = *financial intermediation*; 70-74 = *real estate, renting and business activities*; 75 = *public administration and defence, compulsory social security*; 80 = *education*; 85 = *health and social work*; 90-93 = *other community, social and personal service activities.*

not as much as one could have expected: indeed, they induce matter transformations even if their product itself is not material.

Figure 2: *Lead emissions (direct and indirect) per activated unit of value added and labour input, by vertically integrated industry, Italy, 2000 (tonnes per thousand euro and tonnes per 10 full time equivalent jobs).*



The results shown above are exemplifications only of the results obtained so far. Building on these results, other policy-relevant exercises are possible. These include simulations, e.g., estimates of the emissions avoided thanks to foreign trade, and the use of linear programming mathematics for finding the less onerous ways of meeting given targets. For instance, it is possible to answer to questions such as: *how much will CO_2 emissions decrease system-wide if final demand for the goods of a certain industry decreases by 5%? Assuming given changes in technology, what changes in final demand by industry would minimise the overall reduction of income needed in order to reach a given target for air emissions?*

Yet another interesting application is decomposition analysis, which allows to tell apart the contributions to the overall changes in the emissions and resource intakes of the various relevant phenomena, such as for instance technological change and evolution of level and structure of final demand. This application however is at the moment not possible for Italy since constant price I/O tables are not available.

References

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